Measuring symmetry in real-world scenes using derivatives of the medial axis radius function.

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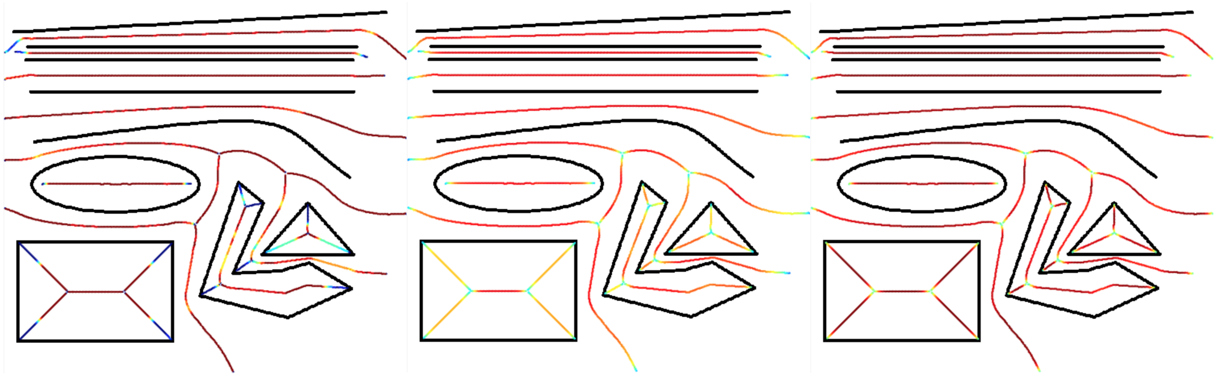
Symmetry has been shown to be an important principle that guides the grouping of scene information. Previously, we have described a method for measuring the local, ribbon symmetry content of line-drawings of real-world scenes (Rezanejad, et al., MODVIS 2017), and we demonstrated that this information has important behavioral consequences (Wilder, et al., MODIVS 2017). Here, we describe a continuous, local version of the symmetry measure, that allows for both ribbon and taper symmetry to be captured. Our original method looked at the difference in the radius between successive maximal discs along a symmetric axis. The number of radii differences in a local region that exceeded a threshold, normalized by the number of total differences, was used as the symmetry score at an axis point. We now use the derivative of the radius function along the symmetric axis between two contours, which allows for a continuous method of estimating the score which does not need a threshold. By replacing the first derivative with a second derivative, we can generalize this method to allow pairs of contours which taper with respect to one another, to express high symmetry. Such situations arise, for example, when parallel lines in the 3D world project onto a 2D image. This generalization will allow us to determine the relative importance of taper and ribbon symmetries in natural scenes.



(a) Original Method (b) First Derivative (c) Second Derivative

Figure 1. : Toy examples of line-drawings (black pixels) with their scored symmetric axes (colored pixels - color denotes symmetry score, high scores in red, low scores in blue). Compare our original method (a) to a method based upon the first derivative of the radius function along the symmetric axis (b) and the second derivative of the symmetric axis (c). The original method results in a change in the score along an axis inside a tapering section (e.g. a corner). The first derivative method scores most highly in the middle of a parallel section, while the axes in a tapering section have a consistent but lower score. The second derivative method scores tapering sections as well as parallel sections highly.

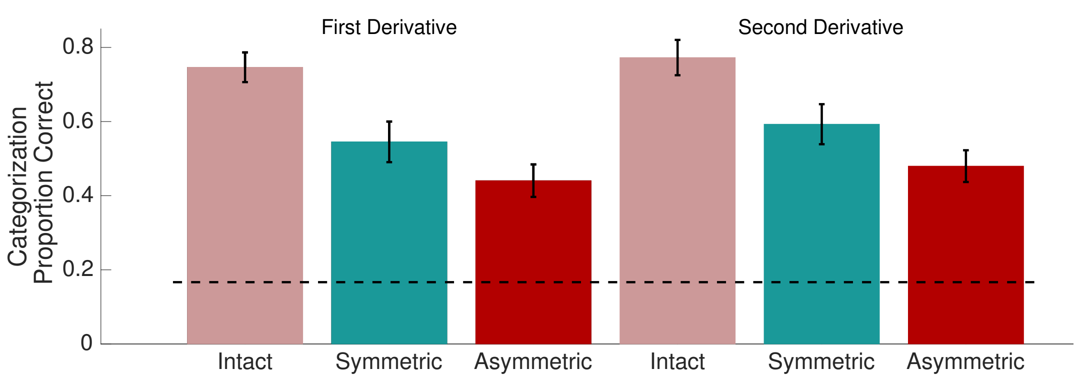


Figure 2. : Proportion correct classification in a rapid classification experiment for intact images or half-images whose contour pixels were separated using the first derivative symmetry score or using the second derivative score. Images in the symmetric condition contain the contour pixels receiving the highest symmetry scores, and the images in the asymmetric condition contain the contour pixels receiving the lowest symmetry scores.